version string (in quotes) is located in FLASH memory starting at address 0x2E0 for access by ICT. It is followed by four zeros ("0000", each a 0x30) and then the usual 0xFF message termination.

[0098] Software Reset Command: 0x3C—Response: System resets and firmware execution starts over.

[0099] Beam Triangle Pair Detection

[0100] The touchframe system monitors pairs of triangular zones. Each triangular zone is comprised of a row of LEDs **24** and a facing IrDA receiver **42**. If beams from each of the overlapping triangular zones are blocked, that triangular zone pair is flagged for later processing.

[0101] Coordinate Conversion and Averaging

[0102] The touchframe controller **44** converts overlapping sloped beams into an orthogonal Cartesian coordinate system. This information is gathered and formatted, as described above, into touch event messages which are sent to the GUI CPU **22** asynchronously whenever they occur.

[0103] Task Structure and Interrupts

[0104] There are two basic threads of operation in the touchframe system: 1) the mainline thread executed in the main operational loop and 2) the interrupt thread executed periodically on the basis of timed interrupts.

[0105] The mainline thread generally takes care of things that are not highly timing dependent and that may be interrupted without serious effect. The interrupt thread takes care of timing and particularly low-level beam detection, which is timing dependent.

[0106] Low-level Beam Detection

[0107] Every 100us a timer-driven interrupt occurs. The next LED **24** out of the endlessly repeating pseudo-random series of LEDs is selected. The LED multiplexing system **46** logic is set up and the selected LED **24** is turned on. As previously mentioned, immediately after the selected LED **24** is turned on, thirty-two sequential samples of the IrDA receiver **42** outputs are taken at ⅛th microsecond intervals. Outputs from both of the IrDA receivers **42** associated with the selected LED **24** are recorded and analyzed by the previously describe touchframe firmware optical noise immunity algorithm to determine if the beam is Noise, Connected or Blocked.

[0108] Beam State Counters

[0109] There is a four-bit state counter associated with each LED/IrDa receiver pair. This counter serves the purpose of low-level debouncing and noise rejection. The associated algorithm allows for a certain amount of hysteresis. A particular LED beam must be observed by the system to be in a new state, i.e., blocked or connected, for at least two samples in a row before it is accepted as having transitioned to that state.

[0110] More specifically, with reference to **FIG. 1**, the most significant bit of the state value defines whether the beam is connected (1) or blocked (0). The "normal" state is connected, i.e., no finger or stylus blocking the beam. When a touch occurs, it takes two scan times to advance the state machine from 0xE to 0x0, a "blocked" state. In the blocked state, higher-level algorithms act on the information if there are two crossed blocked beams. Transitions from state 0x1 to 0x5 occur more slowly. When state 0x5 is reached, the beam is considered to be "timed-out". This means that the higher-level algorithms report a "blocked-beam" error to the host. They also treat the beam in a special way—considering it "blocked" if it is in the middle of a run of blocked beams, or else treating it as "connected" if it is not adjacent to genuinely blocked beams. The "fence" states are not actually beams, but rather act as boundaries for rows of beams. The fences are preset when memory is initialized and never change during touchframe operation. Locked beams are logical states that may be used to implement special error handling algorithms.

[0111] Overlapping Triangular Zone Geometry

[0112] With reference to **FIGS. 12***a* through **12***d*, in one embodiment of the touchframe system there are twelve arbitrarily numbered triangular zones in the touchframe geometry. Each represents a set of infrared LEDs (not shown) and a single IrDA receiver **42**. The IrDA receiver **42** is at the apex of the triangle where the logical beams formed by the IrDA receiver and the LEDs converge. The arrows in the figures indicate which direction the IrDA receivers **42** are looking. While many overlapping combinations of triangles could be devised, in a preferred embodiment of the invention, only sixteen of the possible overlapping pairs are used.

[0113] With reference to **FIGS. 13***a* through **13***j*, the zone pairs are selected to provide coverage of the GUI display. The first four combinations (**FIGS. 13***a* through **13***d*) are one way of covering the lower half of the screen. The second four combinations (**FIGS. 13***e* through **13***h*) are an alternate, redundant way of covering the lower half of the screen. The first four combinations and the second four combinations each use four different IrDA receivers **42**. The last two combinations (**FIGS. 13***i* and **13***j*) are two examples of unused pairs of overlapping triangles. These pairs of overlapping horizontal and vertical triangular zones and others like them are not used in the calculation process because the overlapping lines are not as perpendicular to each other as lines in other pairs, as shown in **FIGS. 13***a*-**13***h*. A similar set of eight combination pairs is used to provide coverage of the upper half of the GUI display.

[0114] A touch event in a triangular zone defines a particular light beam path or line having a particular slope and a particular endpoint. For example, as shown in **FIG. 14**, intersecting lines in triangular zones **6** and **8** are illustrated by the dotted lines. Depending on its location, a touch lies within at least one horizontal triangular zone and at least one vertical triangular zone.

[0115] In accordance with the invention, pairs of the most orthogonally overlapping zones, such as those shown in **FIGS. 13***a*-**13***h*, are selected by the controller **44** firmware and inspected for blocked light beam paths or lines that intersect. The pairs of triangles with beams that intersect at angles closer to 90 degrees are the pairs used for calculating the position of the touch. With reference to **FIG. 14**, the touch **70** lies entirely within horizontal zones **6** and **7** and vertical zone **8**. Zones **6** and **8** form a more orthogonal pair of overlapping triangular zones than zones **7** and **8**. Accordingly, the light beam paths or lines within these zones are examined for blockage. The location of the touch **70** is calculated using two intersecting lines **72**, **74**, one from each